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Physics

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By

CARBIDE AND CARBON CHEMICALS CORPORATION

Plant Engineering Division  
Instrument Engineering Department  
Mechanical Section

DESIGN OF AIR-BORNE ALPHA EMITTER SAMPLER

D. J. Johnson

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Title: Design of Air-Borne Alpha  
Emitter Sampler

Author: D. J. Johnson

CARBIDE AND CARBON CHEMICALS CORPORATION

PLANT ENGINEERING DIVISION  
INSTRUMENT ENGINEERING DEPARTMENT  
MECHANICAL SECTION

A B S T R A C T

An investigation was undertaken to determine the feasibility of either redesigning the existing "Filter Queen" Sampler or to provide a substitute which would overcome some of the undesirable features of the existing sampling unit. As the "Filter Queen" could not be lightened sufficiently to meet the weight requirements of a redesigned unit, it was decided to use a light weight, high speed industrial type blower, such as the Bruer "Tornado". Flow measurement was accomplished by installing a small pressure gauge, calibrated in CFM, up-stream of a fixed orifice on the discharge nozzle. The flow regulator consisted of a simple Butterfly valve located between the filter holder and the blower section nozzle. One unit was assembled and turned over to Radiation Hazards Section for field testing with satisfactory results. It is recommended that the "Tornado" sampler be used for monitoring for air-borne alpha emitters.

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I. OBJECT OF INVESTIGATION:

- 1) To design an air-borne alpha emitter sampler which would be materially lighter than the "Filter Queen" adaption used.
- 2) To simplify the filter paper shape so as to eliminate the necessity of rolling cylindrical filters.
- 3) To provide a simple means of flow indication and flow control.

II. BACKGROUND:

An investigation was undertaken to redesign the existing "Filter Queen" unit or provide a substitute to meet the following specifications:

- 1) The final unit was to weigh not more than 15 pounds.
- 2) The maximum air capacity could not be less than 5 cubic feet per minute.
- 3) The filter was to be of such a shape as to provide easy handling and storage.
- 4) The flow measuring device was to be simple and inexpensive, there being no need for extreme accuracy.
- 5) The flow throttling or varying device to be light and easy to adjust.

III. PROCEDURE:

- 1) Tests were first run to decide on a type, size, and shape of filter paper to use. The flat disc shape was decided upon as it was the simplest form and was also readily available. The size was selected as 9 centimeters diameter as that size was available commercially cut and would also fit into the present laboratory counting chamber with very minor modifications. Whatman #41 filter paper was selected as having the best flow characteristics, that is, highest flow with lowest pressure drop. It also met the necessary requirements as to holding the dust sample and charring down for chemical analysis. The assistance of Mr. C. A. Kienberger of the Laboratory and Mr. G. J. Selvin of Radiation Hazards was invaluable in the selection of the proper paper.
- 2) The "Filter Queen" unit was examined to determine whether or not it could be used. It was decided to use another blower as the "Filter Queen" could not be lightened sufficiently to meet weight requirements. Also, as the air sampled was used to cool the "Filter Queen" motor, it ran very hot under low flow conditions.

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### III. PROCEDURE (Continued):

- 3) A high speed industrial type blower was decided upon. The Bruer Electric Company "Tornado" Blower Model 46 was selected as being sufficient to give a flow of 5 cubic feet per minute through the selected filter paper and to be light enough (9 pounds) to keep the total weight of the completed unit below requirements. As this type blower had a self-cooled motor, cooling troubles were eliminated.
- 4) The flow measuring device was designed with regard to simplicity and inexpensiveness. It consisted of a fixed orifice on the blower discharge nozzle and a pressure gauge having a range of 0-15" H<sub>2</sub>O measuring the orifice up-stream pressure. The orifice was sized to give a maximum up-stream pressure without restricting the flow to less than the filter paper would pass. The pressure gauge was calibrated to read CFM.
- 5) The flow regulating device was a simple Butterfly valve located between the filter paper and blower suction nozzle.

The construction details of the unit may be seen on Drawing C-ID 1778A.

### IV. CONCLUSIONS:

The sampler unit as built met all the requirements as originally specified, being lighter and more compact than the "Filter Queen" sampler. (See Figure 1 attached)

- 1) The final weight was 11-1/2 pounds, or 3-1/2 pounds under maximum allowed.
- 2) The flat filter disc worked satisfactorily giving a maximum flow of 6 CFM or 1 CFM more than specified.
- 3) The flow indicator and the flow control device functioned in a manner which gave good flow readability and easy control, in addition to being simple and light in weight.

The "Tornado" sampler was fabricated (see Figure 2 attached) and turned over to Radiation Hazards Section for field tests. The results were satisfactory except for the inherent noisiness of the blower when running continuous monitoring tests. As it was originally intended to use the blower for a highly portable spot checking unit, there was little thought given to this problem during the initial investigation. However, sound tests were run on the blower at varying speeds. The noise level remained relatively constant having low points of 80 db and peaks of 93 db. These speed variations were equivalent to a flow range of from 2 to 6 CFM. The blower was then removed

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IV. CONCLUSIONS (Continued):

from the motor and noise level checks run on the motor alone. The noise level dropped 4 to 6 db. However, this reduction is meaningless at the high levels encountered. The background level was approximately 45 db. From the tests it can be seen that most of the noise was generated by the motor. The motor noise can be attributed to the sharp edges of the armature slots and motor cooling fan. Quieting of the motor itself seems to be highly unfeasible. The frequency of the noise could not be measured accurately. The main noise was between 25 and 250 cycles with a high frequency noise of over 7500 cycles.

V. RECOMMENDATIONS:

The "Tornado" sampler be used for portable spot checks of short duration. When it is desired to make continuous monitorings a housing of sound absorbing material should be provided to enclose the sampling unit.

Written by:

David J. Johnson  
D. J. Johnson

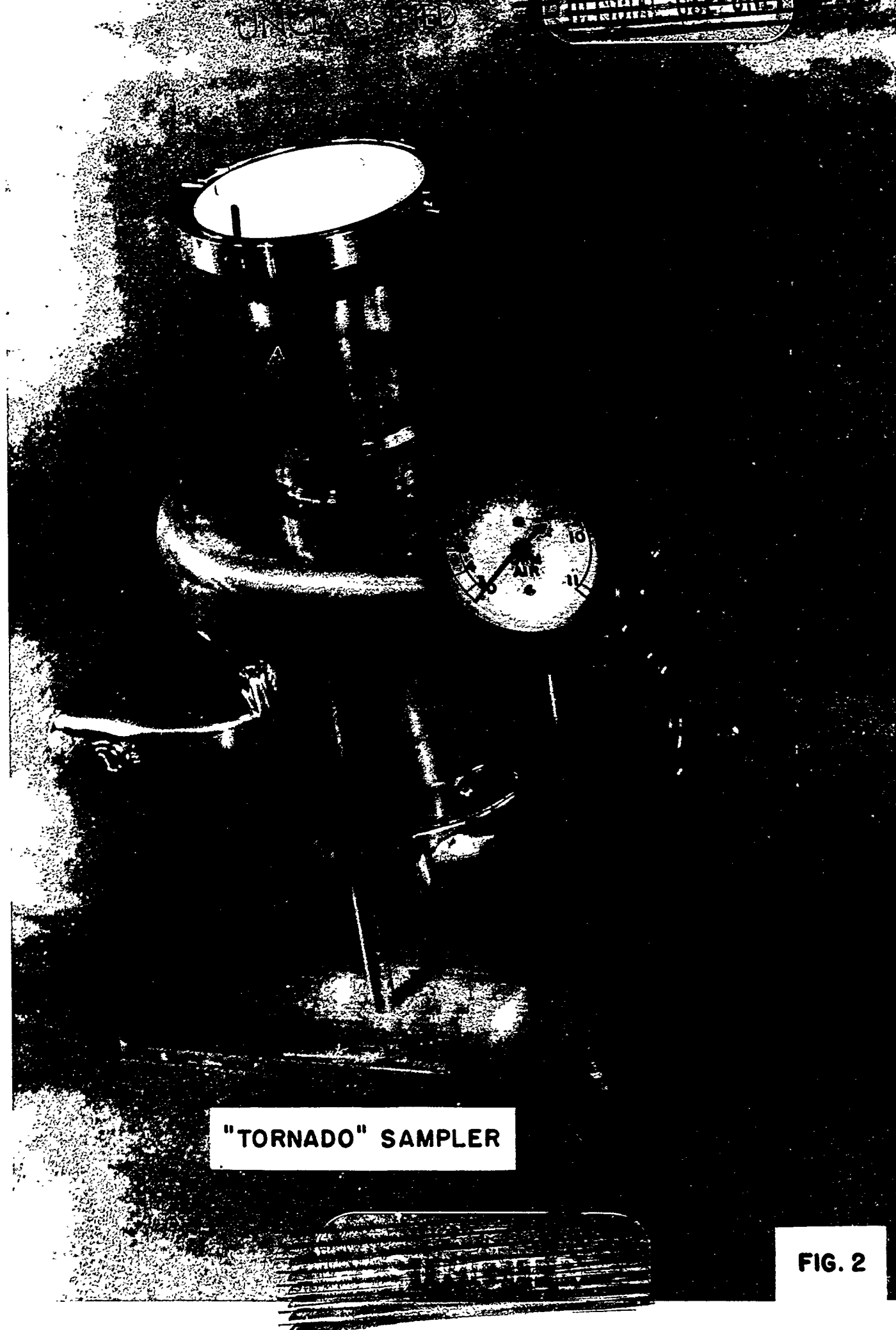
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**"TORNADO" SAMPLER**

**FIG. 2**

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"FILTER QUEEN" SAMPLER

"TORNADO" SAMPLER

FIG. 1

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